

5.3.4.1 Arsenic. Arsenic may occur in natural soils at concentrations ranging between 0.1 to 500 ppm (Dragun, 1988). The common range of arsenic in soils in northeast Ohio in the vicinity of Ashtabula County is 16 to 100 ppm (Shacklette and Boerngen, 1984).

Under aerobic conditions in waters of pH from about 3 to 11, arsenic exists in the +5 oxidation state. Under more reducing conditions in waters of similar pH range as above, arsenic exists in the +3 oxidation state. Arsenic forms anions in solution and therefore does not complex with other anions like  $\text{Cl}^-$ ,  $\text{OH}^-$ ,  $\text{CO}_3^{2-}$ , and  $\text{SO}_4^{2-}$ , but may precipitate as arsenate or arsenite in the presence of metal cations like  $\text{Ca}^{+2}$ ,  $\text{Ba}^{+2}$ , and  $\text{Fe}^{+3}$ .

Arsenic is strongly adsorbed onto soils, by which it can be removed from solution, but is much more mobile in loamy and sandy soils than in clay soils (Bodek, et al., 1988).

Dissolved organic matter can form complexes with arsenic in the +3 and +5 oxidation states, preventing adsorption and precipitation and thereby increasing mobility of arsenic in waters and in soils.

5.3.4.2 Barium. Barium may occur in natural soils in concentrations ranging from 10 to 10,000 ppm (Dragun, 1988). Concentrations in soils in northeast Ohio in the vicinity of Ashtabula County range from 300 to 500 ppm (Shacklette and Boerngen, 1984).

The only oxidation state of barium found under environmental conditions is +2. In most natural waters,  $\text{Ba}^{+2}$  is the dominant species of barium and precipitation of  $\text{BaSO}_4$  (barium sulfate) may control barium concentration in natural waters below pH 9, while  $\text{BaCO}_3$  (barium carbonate) may control at pH above 9. The sulfate and carbonate as well as the fluoride and phosphate salts of barium have low solubility while the chloride, hydroxide, and nitrate of barium are highly soluble.

ECKENFELDER INC.

June 28, 1990

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Mr. Richard L. Mason  
Director, Environmental Affairs  
RMI Titanium Company  
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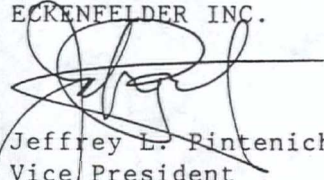
Dear Rick:

Enclosed please find six copies of the revised RCRA Facility Investigation (RFI) Report for the RMI Sodium Plant. The revised report incorporates changes in response to comments issued by the USEPA on April 4, 1990. As agreed in the May 9, 1990 meeting with the USEPA, the revised RFI no longer includes the Health and Environmental Assessment (previously Section 7.0 of the draft RFI) which is concurrently being submitted as part of the CMS Scope of Work.


ECKENFELDER INC. has appreciated this opportunity to further serve RMI. Please let us know if we can be of any further assistance.

Sincerely,

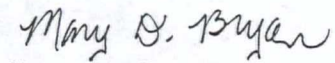
ECKENFELDER INC.



Jeffrey L. Pintenich, P.E., CHMM  
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Specific adsorption of barium occurs onto metal oxides and non-specific adsorption of barium onto soils is a function of the cation exchange capacity of the soil. Organic material present in the soil may also immobilize barium to a limited degree (Bodek et al., 1988).

5.3.4.3 Cadmium. Cadmium may occur in natural soils at concentrations ranging from 0.01 to 45 ppm (Dragun, 1988). Cadmium in soils located in the Lake Plain belt of Ohio have been observed to occur in concentrations up to 2.9 ppm (Logan and Miller, 1983).

The only oxidation state of importance for cadmium under environmental conditions is +2. Cadmium in the +2 oxidation state may be adsorbed to soil, exist as complexes or minerals, or be present in solution as  $\text{Cd}^{+2}$ .

Complexes and minerals of  $\text{Cd}^{+2}$  that may exist in soils are  $\text{CdCO}_3$ , which predominates above about pH 7.5 or higher, depending on the partial pressure of  $\text{CO}_2$ , and  $\text{CdS}$  which can exist over a wide pH range under reducing conditions. Insoluble  $\text{CdS}$  may account for the lower mobility of cadmium in reducing than in oxidizing conditions. Due to the formation of relatively insoluble  $\text{CdCO}_3$ , dissolved calcium levels are lower in hard water than in soft. Other complexes that may occur are  $\text{CdHPO}_4 \cdot 2\text{H}_2\text{O}$ , which may be present in recently fertilized soils, and  $\text{CdOH}^+$  and  $\text{Cd}(\text{OH})_2$ , which may form above a pH of about 8 from the hydrolysis of  $\text{Cd}^{2+}$ , decreasing cadmium mobility. The presence of chloride will compete with insoluble forms of cadmium to produce soluble cadmium chloride complexes, increasing cadmium mobility.

Adsorption of cadmium onto soils, which often correlates with their cation exchange capacity, can significantly reduce cadmium mobility. Clay minerals, carbonate minerals, and oxides can act as adsorbents of cadmium with adsorption increasing with increasing pH.

Ligands such as humic acid and thiosulfate increase cadmium adsorption while other metal cations, such as  $\text{Ca}^{+2}$  and  $\text{Mg}^{+2}$ , reduce adsorption of cadmium on soils (Bodek et al., 1988).

5.3.4.4 Chromium. Chromium may occur in natural soils at concentrations ranging from 0.5 to 10,000 ppm (Dragun, 1988). The range of chromium in soil in northeast Ohio in the vicinity of Ashtabula County is 30 to 50 ppm (Shacklette and Boerngen, 1984).

Under environmental conditions, chromium commonly occurs in the +3 and +6 oxidation states. In water,  $\text{Cr}^{+6}$  hydrolyzes easily and generally exists as an anionic species, such as chromate ( $\text{CrO}_4^{-2}$ ) at pH greater than 6, hydrochromate ( $\text{HCrO}_4^-$ ) at pH less than 6, and dichromate ( $\text{Cr}_2\text{O}_7^{-2}$ ) at low pH and high chromium concentrations.  $\text{BaCrO}_4$ ,  $\text{PbCrO}_4$ , and  $\text{AgCrO}_4$  readily precipitate from solution and control the solubility of  $\text{Cr}^{+6}$ . Although  $\text{Cr}^{+3}$  also hydrolyzes in water, because the kinetics are slow, it generally exists as cationic species.  $\text{Cr}(\text{OH})_2^+$ ,  $\text{Cr}(\text{OH})^{+2}$ , and  $\text{Cr}_3(\text{OH})_4^{+5}$  are expected to predominate in the pH range of 5 to 9. In natural waters at pH above 5, the solubility of  $\text{Cr}^{+3}$  is controlled by precipitation of  $\text{Cr}(\text{OH})_3$  and  $\text{FeCr}_2\text{O}_4$ .

In soils, organic matter can cause the reduction of  $\text{Cr}^{+6}$  to  $\text{Cr}^{+3}$ , while the magnesium oxides can oxidize  $\text{Cr}^{+3}$  to  $\text{Cr}^{+6}$ . The adsorption of  $\text{Cr}^{+3}$  onto soils increases as pH increases while the adsorption of  $\text{Cr}^{+6}$  on soils decreases as pH increases. The most mobile forms of chromium in soils are chromate ( $\text{CrO}_4^{-2}$ ) and dichromate ( $\text{Cr}_2\text{O}_7^{-2}$ ), which are not adsorbed appreciably by most soils and form soluble salts in aerobic conditions, but are reduced to  $\text{Cr}^{+3}$  and precipitate under anaerobic conditions. In clay soils, it was found that 30 to 300 times more  $\text{Cr}^{+3}$  was adsorbed than  $\text{Cr}^{+6}$  (Bodek et al., 1988).

5.3.4.5 Lead. The range of lead in natural soils is 0.1 to 3,000 ppm (Dragun, 1988). The common range of lead in northeast Ohio in the vicinity of Ashtabula County is 30 to 700 ppm (Shacklette and Boerngen, 1984).

Most lead under environmental conditions exists in the +2 oxidation state, which may be found as insoluble  $\text{PbS}$  (galena) under reducing conditions, low solubility  $\text{PbCO}_3$  (cerussite),  $\text{PbSO}_4$ ,  $\text{PbHCO}_3^+$ ,  $\text{Pb}_3(\text{PO}_4)_2$ ,  $\text{Pb}(\text{OH})_2$ ,  $\text{PbOH}^+$ , adsorbed to soil, or may be present in solution as  $\text{Pb}^{+2}$ . Elemental lead may also be found under extreme reducing conditions and pH well above 6.



Clay minerals, organic matter, and oxides can act as adsorbents of lead in soils, with the extent of sorption generally increasing with increasing pH. The presence of ligands such as humic acid have been shown to increase the sorption of lead by soils, especially at lower pH (6 and below). The mobility of lead in soils is controlled mainly by the adsorption of lead to the soil and by the formation of  $\text{PbCO}_3$ , which in turn is dependent on the partial pressure of  $\text{CO}_2$  in the soil. Halide complexes of lead are not usually significant in soils (Bodek et al., 1988).

5.3.4.6 **Mercury.** The common range of mercury in natural soils is 0.1 to 0.3 ppm (Lindsay, 1979). In northeast Ohio in the vicinity of Ashtabula County, mercury may occur in concentrations ranging from 0.03 to 0.05 ppm (Shacklette and Boerngen, 1984).

The important oxidation states of mercury in the environment are 0 ( $\text{Hg (liq)}$ ), +1 ( $\text{Hg}_2^{+2}$ ), and +2 ( $\text{Hg}^{+2}$ ). Mercury is very soluble in oxidized aquatic conditions but is strongly sorbed onto soils and sediments, limiting its mobility. Iron oxides, manganese oxides, clays, and organics are important sorbents of mercury in soils with organic content being the most important (Bodek et al., 1988). However, the presence of  $\text{Cl}^-$  can decrease sorption by forming poorly sorbed  $\text{Hg-Cl}$  complexes.  $\text{Hg (OH)}_2$ , which predominates in oxidized aqueous systems of pH around 6.5 and higher, is probably the most highly sorbed species. Under reducing conditions, insoluble  $\text{HgS}$  may form if sulfur is present, while  $\text{Hg}^0$  is the most likely insoluble species under conditions of intermediate Eh.

5.3.4.7 **Nickel.** The range of nickel for natural soils is 0.8 to 6,200 ppm (Dragun, 1988). Nickel concentrations in soils of northeast Ohio in the vicinity of Ashtabula County range from 10 to 15 ppm (Shacklette and Boerngen, 1984).

The only oxidation state nickel normally exists in, under environmental conditions, is +2. In water under aerobic conditions and normal pH ranges, nickel will form relatively insoluble compounds with the anions present, especially hydroxide and  $\text{FeO}_4^{-2}$  which may control nickel solubility under most environmental conditions (Bodek, et al., 1988). However, the presence of organic ligands such as humic acid can significantly increase the extent of nickel solubilization.

Nickel is thought to be adsorbed on soils containing oxides and clay minerals, however, it is considered to be one of the more mobile of the heavy metals as the presence of other cations and organic acids can reduce nickel adsorption (Bodek et al., 1988).

5.3.4.8 Selenium. The range for selenium in natural soils is 0.01 to 400 ppm (Dragun, 1988). Selenium commonly occurs in the range of 0.15 to 0.3 ppm in northeast Ohio in the vicinity of Ashtabula County (Shacklette and Boerngon, 1984).

The chemistry of selenium is similar to that of sulfur. Natural sulfur deposits often contain selenium and naturally occurring metal sulfides have been found to contain up to 20 percent selenium (Bodek et al., 1988).

In natural environments, selenium is found in the -2, 0, +4, and +6 oxidation states. The +4 and +6 oxidation states are represented by  $\text{SeO}_3^{-2}$  (selenites) and  $\text{SeO}_4^{-2}$  (selenates) respectively. In aqueous solution, selenium generally exists in an anionic form, as  $\text{HSeO}_3^{-}$  at acidic to intermediate pH and intermediate to oxidizing conditions, and as  $\text{SeO}_4^{-}$  at alkaline pH and oxidizing conditions. These anions can form soluble complexes and insoluble salts with many metals, although selenate salts are generally more soluble than selenite salts. Ferric selenite and ferric hydroxy selenite have very low solubilities which minimizes selenite mobility in soils.



Elemental selenium,  $\text{Se}^0$ , is insoluble in water and is found in the lower pH range (below 7) and mildly reducing conditions. Selenium in the -2 oxidation state,  $\text{Se}^{-2}$ , is unstable in water but its oxidation to  $\text{Se}^0$  occurs very slowly. Therefore, selenium can exist as  $\text{H}_2\text{Se}$  (hydrogen selenide) and  $\text{HSe}^-$  in solution under reducing conditions. Under these conditions, many heavy metals can be precipitated as the insoluble metal selenide.

Selenium is adsorbed to a high degree by oxides and somewhat by clays although adsorption of selenium on soils is affected by pH and redox conditions, the presence of organics, the presence of other anions, as well as by clay and oxide content. The adsorption of selenium onto iron oxides is reduced by the presence of phosphates and sulfates which can release up to 90 percent of the selenite and selenate adsorbed on a soil. Generally, selenite and selenate adsorption on soils decreases with increasing pH, and plants can accumulate high levels of selenium in alkaline soils while little selenium is available for plant accumulation in acidic soils. Volatilization of selenium through biological methylation can occur in plants and in soils, and although this process detoxifies selenium, it may be an important process to consider when attempting to determine the fate of selenium in the environment (Bodek *et al.*, 1988).

**5.3.4.9 Silver.** The common range of silver concentration in soils is 0.01 to 5.0 ppm (Lindsay, 1979). The extreme range for native soils is 0.01 to 50 ppm (Dragun, 1988).

In soils and other natural environments, only silver in the 0 and +1 oxidation states is found.  $\text{Ag}^+$  can occur as the essentially insoluble sulfide ( $\text{Ag}_2\text{S}$ ) in reducing conditions, as relatively insoluble halides (especially  $\text{AgCl}$ ,  $\text{AgBr}$ , and  $\text{AgI}$ ), and as relatively soluble oxides, sulfates, carbonates, and phosphates.  $\text{Ag}^0$  may also form under reducing conditions.

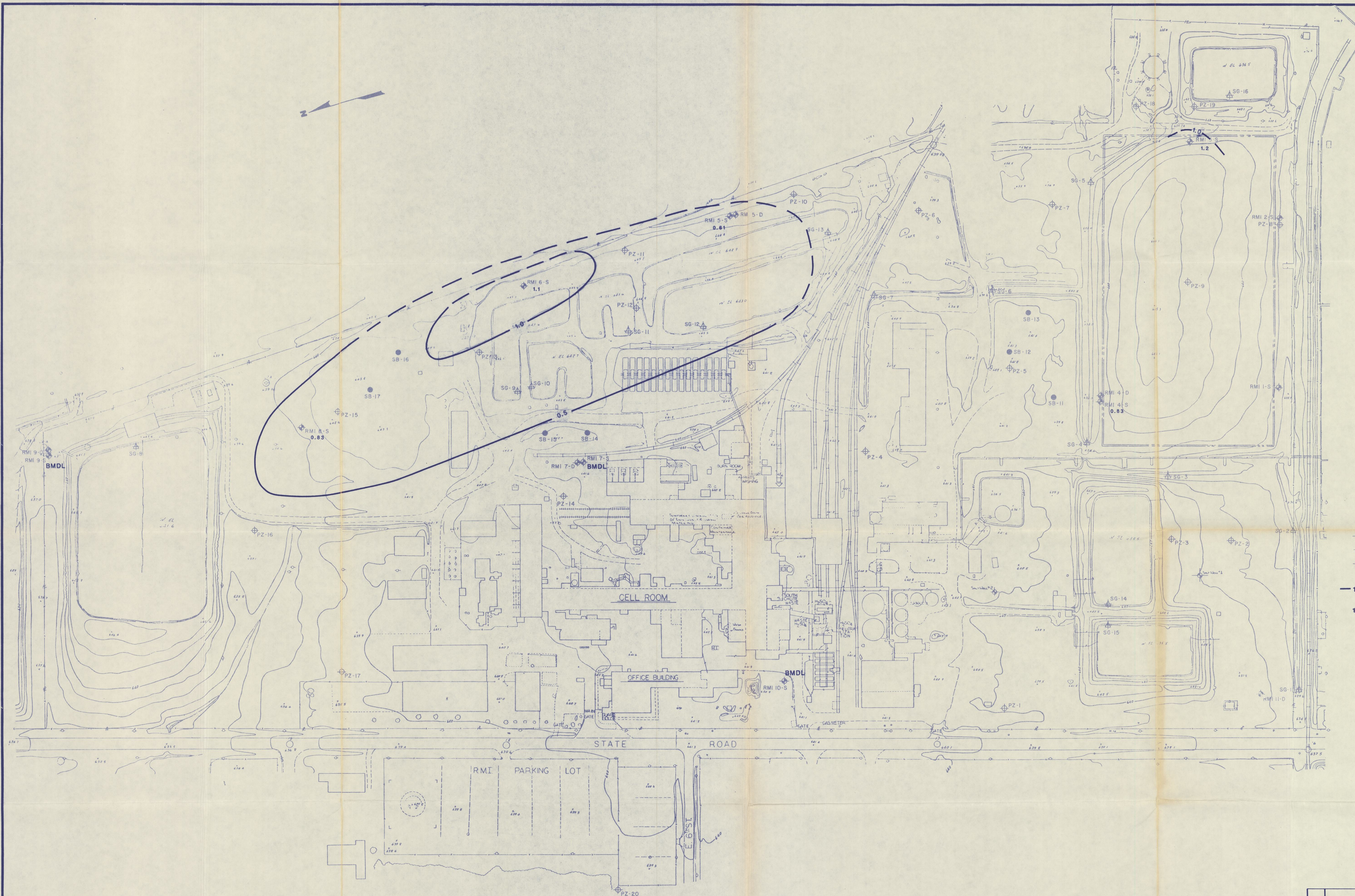
Silver is adsorbed by oxides and clays in soils, however, desorption can readily occur through the formation of complexes allowing for greater mobilization (Bodek *et al.*, 1988).

5.3.4.10 Zinc. The typical range of zinc in natural soils is 10 to 300 ppm (Dragun, 1988). In northeast Ohio in the vicinity of Ashtabula County, zinc may occur in concentrations ranging from 74 to 120 ppm (Shacklette and Boerngen, 1984).

The only oxidation state of importance for zinc under environmental conditions is +2. Its solubility in natural waters is strongly affected by both pH and Eh. At pH of from 4 to about 7.5, the predominant species of zinc in fresh water is  $Zn^{+2}$ . In this pH range, precipitation of  $Zn(OH)_2$  or  $ZnCO_3$  can occur if  $Zn^{+2}$  is present in high enough concentrations. However, above a pH of about 7.7, soluble  $Zn(OH)_2^0$  is the predominant species, which can lead to increased mobilization of zinc since the insoluble carbonates or hydroxides are not formed. Under reducing conditions, and if there is sulfur present, zinc sulfide will precipitate, limiting zinc mobility.

The solubility of Zn in soil water is related to the sorption capacity of the soil. Iron and manganese oxides, clays, carbonate minerals, and to a lesser extent organic matter adsorb zinc onto soils and can control Zn mobility. Sorption of zinc is dependent on pH and increases with increasing pH, especially in the pH range of about 5 to 8 (Bodek, et al., 1988).





- LEGEND:**
- ⊕ PIEZOMETER
  - △ STREAM GAUGE
  - ⊙ MONITORING WELL
  - SOIL BORING
  - 1.0 ISOCONCENTRATION CONTOUR IN PPM, DASHED WHERE INFERRED
  - - - 1.2 OBSERVED CONCENTRATION OF BARIUM, IN PPM

NO.	REVISIONS	REV'D BY	DATE
<b>RMI SODIUM PLANT</b> Ashtabula, Ohio			
<b>FIGURE 6-1</b> GROUNDWATER ISOCONCENTRATION MAP, BARIUM (ppm), JANUARY 1989			
DRAWN BY		CHECKED BY	APPROVED BY
DRAWING NUMBER			

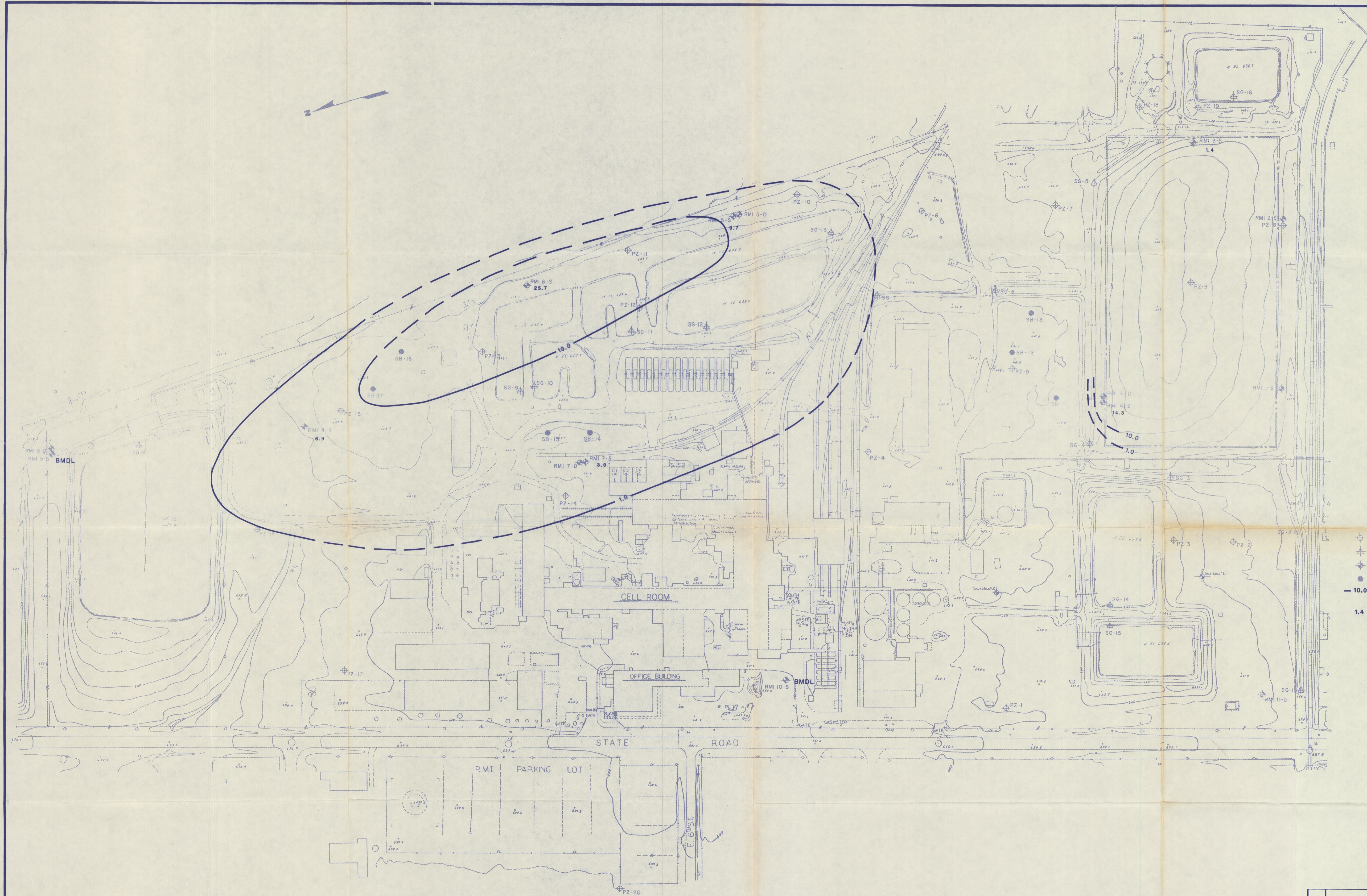


NASHVILLE, TENNESSEE  
MAHWAH, NEW JERSEY

SCALE: 1" = 100'


100 0 100 200  
scale feet





- LEGEND:
- ⊕ PIEZOMETER
  - ⊕ STREAM GAUGE
  - ⊕ MONITORING WELL
  - SOIL BORING
  - 10.0 — ISOCONCENTRATION CONTOUR IN PPB, DASHED WHERE INFERRED
  - 1.4 OBSERVED CONCENTRATION OF CADMIUM, IN PPB



		NASHVILLE, TENNESSEE MAHWAH, NEW JERSEY	
SCALE: 1" = 100'		<b>RMI SODIUM PLANT</b> Ashtabula, Ohio	
DRAWN BY DATE CHECKED BY APPROVED BY		<b>FIGURE 6-2</b> <b>GROUNDWATER ISOCONCENTRATION MAP,</b> <b>CADIUM (ppb), JANUARY 1989</b>	
		DRAWING NUMBER	



## 6.0 CONTAMINANT RELEASE ASSESSMENT

### 6.1 GROUNDWATER

In order to define the quality of the groundwater within the RMI Sodium Plant site, groundwater samples from 15 recently installed monitoring wells were collected and analyzed. The groundwater quality database consists of analytical results from two sampling episodes, conducted in November 1988 and January 1989. The groundwater sampling procedures and parameters were previously discussed in Section 3.7 of this report. All groundwater quality analytical data are presented in Appendix 9.

#### 6.1.1 Shallow Water-Bearing Zone

Groundwater has been observed to occur in an unconfined water table zone within the low to moderate hydraulic conductivity glacial till. A total of 10 monitoring wells have been screened within the shallow water-bearing zone and groundwater has been sampled and analyzed for a variety of constituents. This section summarizes the occurrence of metals in the shallow groundwater zone. The occurrence of organic parameters is subsequently discussed in Section 6.6 of this report.

**6.1.1.1 Waste Constituents Identified.** In the closed landfill and former fill areas at the RMI site, barium, cadmium, and lead were suspected hazardous constituents. In addition, previous samples from the wastewater treatment ponds have contained trace amounts of chromium, lead, selenium, and silver. The groundwater in the glacial till was analyzed for arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. These metals could not effectively be analyzed in the groundwater samples from wells 1S and 2S due to the high concentrations and very complex nature of the organics (see Section 3.7). The metals data are summarized in Table 6-1.

TABLE 6-1

## DISSOLVED METALS IN GROUNDWATER

Well Number	Sample Date	Concentration (ppb)								
		pH	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
3S	11/18/88	6.39	BMDL <sup>a</sup>	910	4.0	9.8	BMDL	BMDL	BMDL	BMDL
	1/11/89	7.08	BMDL	1,200	1.4	9.7	BMDL	BMDL	1.1	BMDL
4S	11/17/88	--	BMDL	BMDL	11.8	14.5	BMDL	0.6	1.5	BMDL
	1/11/89	7.12	BMDL	830	14.3	8.0	BMDL	BMDL	BMDL	BMDL
4D	11/17/88	--	BMDL	6,200	2.6	8.2	BMDL	0.6	BMDL	BMDL
	1/11/89	6.94	BMDL	6,800	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL
5S	11/18/88	6.42	BMDL	530	6.5	9.8	BMDL	BMDL	BMDL	BMDL
	1/11/89	7.10	BMDL	610	9.7	6.9	BMDL	BMDL	BMDL	BMDL
5D	11/18/88	7.08	BMDL	6,210	2.0	5.8	BMDL	BMDL	BMDL	BMDL
	1/11/89	7.00	BMDL	5,600	2.8	8.3	BMDL	BMDL	BMDL	BMDL
6S	11/18/88	6.34	BMDL	1,500	18.3	BMDL	BMDL	BMDL	3.7	BMDL
	1/12/89	7.04	BMDL	1,100	25.7	BMDL	BMDL	0.4	2.4	BMDL
7S	11/17/88	7.15	BMDL <sup>b</sup>	BMDL	8.3	5.9	BMDL	BMDL	BMDL	BMDL
	1/12/89	6.98	BMDL/BMDL <sup>b</sup>	BMDL/BMDL	3.0/4.0	BMDL/BMDL	BMDL/BMDL	BMDL/BMDL	BMDL/BMDL	BMDL/BMDL
7D	NA <sup>c</sup>	NA	NA	NA	NA	NA	NA	NA	NA	NA
	1/13/89	--	9.0	BMDL	BMDL	8.1	BMDL	BMDL	BMDL	BMDL
8S	11/18/88	6.29	BMDL	1,900	11.7	BMDL	BMDL	BMDL	BMDL	BMDL
	1/12/89	7.02	BMDL	830	6.9	13.0	BMDL	BMDL	BMDL	BMDL
9S	11/16/88	7.35	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL
	1/12/89	6.98	BMDL/BMDL	BMDL/BMDL	BMDL/1.3	13.6/BMDL	BMDL/BMDL	BMDL/BMDL	BMDL/BMDL	BMDL/BMDL
9D	11/16/88	7.83	BMDL	1,100	2.7	6.1	BMDL	BMDL	BMDL	BMDL
	1/12/89	6.99	BMDL	1,400	6.3	13.5	BMDL	BMDL	BMDL	BMDL
10S	11/16/88	6.94	BMDL/BMDL	BMDL/BMDL	BMDL/BMDL	BMDL/6.1	BMDL/BMDL	BMDL/BMDL	BMDL/BMDL	BMDL/BMDL
	1/13/89	7.08	BMDL	BMDL	BMDL	8.4	BMDL	BMDL	BMDL	BMDL
11D	11/17/88	7.67	BMDL/BMDL	3,400/5,800	7.9/BMDL	7.1/6.7	BMDL/BMDL	BMDL/BMDL	BMDL/BMDL	BMDL/BMDL
	1/12/89	7.12	BMDL	18,000	7.2	11.6	BMDL	BMDL	BMDL	BMDL
Field Blank	11/17/88	7.05	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL
	1/12/89	7.05	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL
Detection Limits		--	5.0	500	1.0	5.0	10.0	0.4	1.0	30.0

<sup>a</sup>BMDL = Below Method Detection Limit<sup>b</sup>Field Duplicate<sup>c</sup>NA = Not Analyzed - Dry well



Arsenic, lead, and silver were not detected in any shallow groundwater samples, therefore, these metals have been eliminated from further discussion. Mercury and selenium were detected in trace amounts at or near detection limits, in wells 4S and 6S, and wells 3S and 4S, respectively. Selenium was detected during both sampling events in samples collected from well 6S. Based on frequency of detection and relative minor concentrations, mercury and selenium were also eliminated from further discussion. With the exception of well 6S (in which chromium was not detected), chromium was present in amounts approximately equal to or below background values in all wells. Therefore, chromium does not warrant further discussion.

Wells 9S and 10S are considered background wells due to their locations with respect to the ponds and fill areas. These wells may not be upgradient to the entire site due to the complex groundwater flow pattern. However, they are the wells furthest away from the SWMUs and are in areas that have not been impacted by the SWMUs. Background wells truly upgradient to the entire site would have to be located off site. Major ion data (Figure 4-15) indicate that the background wells (9S and 10S) have distinctively different groundwater chemistry than the wells associated with the SWMUs and indicate that these wells are representative of conditions that are background to the SMWUs.

Barium and cadmium were the only metals consistently detected above background values. Background barium concentrations were BMDL (below method detection limit) while other barium concentrations ranged from BMDL in wells 7S and 4S (11/88) to 1,900 ppb in well 8S (11/88). Background cadmium concentrations were BMDL while other cadmium concentrations ranged from 1.4 ppb in well 3S (1/89) to 25.7 ppb in well 6S (1/89). Figures 6-1 and 6-2 are isoconcentration maps of barium and cadmium, respectively, in the glacial till groundwater. The highest concentrations of barium and cadmium occur near the closed landfill near the southern property boundary (Area A) and the wastewater treatment ponds and fill areas near the eastern property boundary (Areas D, E, F, G).

6.1.1.2 Rate and Direction of Waste Constituent Migration. The direction of contaminant (barium and cadmium) migration in groundwater appears to radiate outward from the mounded groundwater in the vicinity of the five ponds near the eastern property boundary. The direction of contaminant migration in the vicinity of the closed landfill cannot be adequately defined with only two data points, but is assumed to flow outward towards the DS tributary of Fields Brook. The rate of shallow groundwater flow has been determined (Section 4.2.2) to be approximately 0.7 ft/yr throughout the majority of the site and 7.0 ft/yr immediately adjacent to the clay lined wastewater treatment ponds.

Groundwater discharge occurs to the DS tributary of Fields Brook in the vicinity of the closed landfill, and to the drainage ditch east of the five clay lined ponds. As discussed in Section 4.2.2, the groundwater discharge per linear foot to the DS tributary and drainage ditch is 0.05 gal/day and 0.5 gal/day, respectively. Using equation 4.2, the total groundwater discharge to the DS tributary, assuming a length of 3,300 ft and a water depth of 1 ft, is approximately 181 gal/day. However, this is assumed to be a conservative value due to intermittent flow in the DS tributary because of seasonal variations.

The total groundwater discharge to the drainage ditch east of the wastewater treatment ponds, assuming a length of 1,200 ft and a water depth of 1 ft, is approximately 660 gal/day. However, because there are no monitoring wells or piezometers in the vicinity of the drainage ditch east of the ponds or staff gauges installed in this ditch, detailed information is lacking as to the quantity of groundwater discharging into the ditch. In addition, the flow patterns in that area that are controlled by recharge from the ponds may also be complicated by the coal pile located each of the ditch. The discharge value of 660 gal/day calculated for this ditch represents a worse case scenario.

The rate of barium and cadmium migration in the groundwater is controlled by the speciation and sorption of the barium and cadmium ions, as was discussed in Section 5.3.3.



### 6.1.2 Bedrock Water-Bearing Zone

Groundwater has been observed to occur in a confined water-bearing zone within the low hydraulic conductivity shale. Five monitoring wells (4D, 5D, 7D, 9D, 11D) have been screened within the shale and groundwater has been sampled and analyzed for eight metals. The metals data are summarized in Table 6-1.

The direction of bedrock groundwater flow is expected to be north towards Lake Erie as is the case at the nearby RMI Extrusion Plant located approximately 1/2 mile from the Sodium Plant facility. Under these conditions, well 11D is upgradient relative to the RMI Sodium Plant SWMUs and represents background conditions for the bedrock zone. The only three metals detected in the groundwater in well 11D were barium, cadmium, and chromium. These three metals were detected in concentrations higher than those in all other bedrock wells. No other metals were detected in the shale groundwater zone with the exception of trace amounts of mercury in well 4D and arsenic in well 7D. Therefore the metal occurrences in the shale groundwater zone are background.

In addition, barium was the only metal consistently detected in the bedrock groundwater wells and it occurred in concentrations greater than the shallow groundwater background values. The presence of barium in the deep bedrock groundwater does not necessarily indicate a connection with the SWMUs on site. As stated in Section 4.2.2.2, based upon the low permeability and considerable thickness of the unweathered glacial till, and the relatively small hydraulic gradient between the bedrock and the shallow aquifer, it is apparent that only a minimal downward component of flow exists between the two water bearing zones. In addition, major ion data (indicated on Figure 4-15) demonstrate that the bedrock wells have a distinctively different groundwater chemistry than the shallow wells.

Barium/chloride ratios in the bedrock and shallow aquifers are also inconsistent with the hypothesis that the deep groundwater had been impacted by the shallow groundwater. Because chloride is a very conservative ion

(i.e., is not readily attenuated), chloride would migrate along a downward vertical gradient more quickly than barium, which may be attenuated more readily than the chloride ion. Barium in the deep groundwater occurs at higher concentrations than shallow groundwater while chloride concentrations in the deep groundwater are much lower than in shallow groundwater. These inverted ratios indicate that the barium in the deep groundwater could not have originated from the shallow aquifer, but rather is naturally occurring. Therefore, water quality in the bedrock groundwater is not affected by the SWMUs on site.

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## 6.2 SOIL

### 6.2.1 Surficial Soil

Surficial soil samples were collected from five areas on the plant site (Areas A, B, C, F, and G) and analyzed for nine metal parameters. The analytical results of this sampling effort are summarized in Table 6-2. Laboratory analytical sheets are contained in Appendix 9.

A statistical test, the Student's t test for distributions with possible different variances, was applied to the surficial soil metals data. It is used to assess the significance of the differences in means found between samples from background and test areas. There are twelve site background samples, and four test samples from each of five site areas (Figure 3-1). The data were log transformed (natural log) before applying the statistical test to reduce the effect of the large scatter in some of the test data. The log transformed data are more likely to approximate a normal distribution than the original data and the results of the statistical tests should be more reliable. This was necessary in that there were insufficient data to determine the actual distributions. Analytical results indicated as below the method detection limit (BMDL) were assumed to be equal to the detection limit for the purpose of the analysis. This reduces the difference between the test and background means when non-detects occur and increases the probability that any differences found are real. Negative test and background means are natural logs of values less than one.



TABLE 6-2  
SURFICIAL SOILS  
METALS DATA<sup>a</sup>

Surficial Soil Sample	Ba	Cd	Pb	Cr	Ni	Ag	Hg	As	Se
Landfill Cap (Area A)									
SS1-1	53.7	BMDL <sup>b</sup>	BMDL	13.5	28.3	BMDL	BMDL	16.4	BMDL
SS1-2	78.5	BMDL	BMDL	15.2	23.0	BMDL	BMDL	15.2	BMDL
SS1-3	90.9	BMDL	15.3	15.2	21.2	BMDL	BMDL	12.6	BMDL
SS1-4	78.5	BMDL	BMDL	15.2	17.7	BMDL	BMDL	14.1	BMDL
Average <sup>c</sup>	75.4	BMDL	15.1	14.8	22.6	BMDL	BMDL	14.6	BMDL
North of Landfill (Area C)									
SS2-1	1,240	26.4	83.4	22.9	255	BMDL	BMDL	23.4	0.69
SS2-2	382	2.59	15.3	12.7	24.8	BMDL	BMDL	21.6	0.54
SS2-3	155	1.24	209	34.7	743	BMDL	0.72	18.9	0.75
SS2-4	603	BMDL	BMDL	9.3	17.7	BMDL	BMDL	23.0	0.75
Average <sup>c</sup>	595	7.81	80.7	19.9	260	BMDL	0.33	21.7	0.68
Northeast of Landfill (Area B)									
SS3-1	1,230	46.5	141	18.6	177	BMDL	BMDL	13.6	BMDL
SS3-2	2,590	18.2	99.2	27.1	442	BMDL	1.29	23.6	0.72
SS3-3	1,880	731	1,140	25.4	558	BMDL	BMDL	12.8	BMDL
SS3-4	593	1.35	41.5	12.7	28.3	BMDL	BMDL	23.5	0.70
Average <sup>c</sup>	1,573	199	355	21.0	301	BMDL	0.47	18.4	0.60
West of Ponds (Area F)									
SS4-1	474	3.41	62.5	13.5	40.7	BMDL	0.27	13.1	BMDL
SS4-2	353	3.82	93.9	16.9	47.8	BMDL	0.33	23.0	BMDL
SS4-3	211	2.59	152	33.0	117	BMDL	BMDL	18.0	BMDL
SS4-4	233	2.59	41.5	18.6	37.2	BMDL	BMDL	16.4	BMDL
Average <sup>c</sup>	317.8	3.10	87.5	20.5	60.7	BMDL	0.25	17.6	BMDL
North of Ponds (Area G)									
SS5-1	132	15.9	33.7	18.6	32.8	BMDL	BMDL	22.4	0.94
SS5-2	101	8.33	31.1	19.5	28.3	BMDL	BMDL	10.0	0.64
SS5-3	105	5.05	25.8	16.9	33.6	BMDL	BMDL	18.3	BMDL
SS5-4	140	3.00	25.8	19.5	24.8	BMDL	0.51	23.5	0.84
Average <sup>c</sup>	119.5	8.07	29.1	18.6	29.9	BMDL	0.28	18.5	0.73
Background									
SSB-1	124	BMDL	20.6	16.9	26.5	BMDL	BMDL	16.1	BMDL
SSB-2	86.8	BMDL	20.6	15.2	23.0	BMDL	BMDL	14.7	BMDL
SSB-3	120	5.46	31.1	17.8	31.8	BMDL	BMDL	17.0	0.51
SSB-4	178	BMDL	25.8	16.9	53.1	BMDL	0.23	11.5	0.62
SSB-5	60.1	BMDL	60.5	14.6	11.5	BMDL	BMDL	15.9	BMDL
SSB-6	127	41.6	16.6	14.6	63.0	BMDL	BMDL	10.8	BMDL
SSB-7	51.1	BMDL	BMDL	11.1	7.0	BMDL	BMDL	8.3	BMDL
SSB-8	42.2	BMDL	BMDL	11.1	11.5	BMDL	BMDL	13.1	BMDL
SSB-9	42.2	BMDL	16.6	9.0	BMDL	BMDL	BMDL	10.9	BMDL
SSB-10	37.7	BMDL	36.1	9.7	BMDL	BMDL	BMDL	BMDL	BMDL
SSB-11	195	BMDL	BMDL	12.5	12.5	BMDL	BMDL	8.8	BMDL
SSB-12	105	BMDL	26.4	18.1	63.0	BMDL	BMDL	12.0	BMDL
Average <sup>c</sup>	97.4	4.75	24.9	14.0	26.1	BMDL	0.20	12.0	0.51
Detection Limit	25.0	1.0	15.0	2.5	5.0	1.5	0.2	5.0	0.5

<sup>a</sup>Concentrations expressed in ppm.

<sup>b</sup>BMDL = Below Method Detection Limit.

<sup>c</sup>If an analytical result was below the method detection limit (BMDL), the value of the detection limit was used in averaging.

The results of the statistical tests are given in Table 6-3. For each metal in each test location, the following results are given: the mean of the test data, the mean of the background data, the variance of the test data, the variance of the background data, the "T" statistic value, and the probability that the difference between the mean values could have occurred by chance. The lower the probability, the less likely it is that the test and background areas are the same for that metal. Probability values less than about 0.05 (i.e., the 95 percent confidence interval) show quite significant differences between test and background data.

Some care is necessary in interpreting the results of the Student's t test. In particular, although the test adjusts for differences in the variances between test and background samples, very large differences in variance make the test itself suspect. For example, the data for chromium in the North of Ponds area yields a probability of 0.0006 which appears very significant. Other test areas show much higher probability values (from 0.5 to 0.23), but the mean value for the area north of the wastewater treatment ponds is quite typical. The explanation appears in an examination of the variances. The variance of the test samples is an order of magnitude less than the background variance and much lower than the variance of any other set of test data (except the landfill data) which combined with the elevated mean (all four measurements are noticeably higher than the background mean), leads to the low probability estimate. What is not clear is whether this site is significantly more contaminated than the others which have much more scattered data. Another situation for care occurs when there is a very large test sample variance which can "wash out" an apparently large difference in means and lead to probabilities greater than 0.05; an example is cadmium northeast of the landfill. Another example is lead in the area north of the landfill. Although the probability value calculated is greater than 0.05, it is likely that the average value calculated for lead in this area (80.7 ppm) is significantly above background. These types of arguments could possibly be made more rigorous by performing more statistical tests.

One other anomalous result occurs for lead in the landfill cap. There is a significant difference between the background and test means, but the test mean is lower. This can probably be explained by the off site origin of the



TABLE 6-3

## SUMMARY OF STUDENT'S T STATISTICAL TEST DATA

## Soil Metals Data, Log Transformed (ppm)

Non-Detectable Data Assumed to have a Value at the Detection Limit

## LANDFILL CAP (Area A)

	<u>Ba</u>	<u>Cd</u>	<u>Pb</u>	<u>Cr</u>	<u>Ni</u>	<u>Hg</u>	<u>As</u>	<u>Se</u>
mean	4.30	0.00	2.71	2.69	3.10	-1.61	2.67	-0.69
BK mean	4.43	0.45	3.12	2.61	2.78	-1.60	2.24	-0.67
variance	0.0507	0.0	0.000098	0.00352	0.0379	0.0	0.0126	0.000000
BK VAR	0.338	1.302	0.186	0.0587	1.264	0.00163	0.908	0.00382
T	0.62	1.37	3.27	1.07	0.96	1.00	1.55	1.10
PROB	0.272	0.0986	0.00372	0.151	0.178	0.169	0.0741	0.148

## NORTH OF LANDFILL (Area C)

	<u>Ba</u>	<u>Cd</u>	<u>Pb</u>	<u>Cr</u>	<u>Ni</u>	<u>Hg</u>	<u>As</u>	<u>Se</u>
mean	6.13	1.10	3.80	2.86	4.56	-1.29	3.08	-0.39
BK mean	4.43	0.45	3.12	2.61	2.78	-1.60	2.24	-0.67
variance	0.758	2.265	1.703	0.348	3.278	0.410	0.00939	0.0242
BK VAR	0.338	1.302	0.186	0.0587	1.264	0.00163	0.908	0.00382
T	3.64	0.79	1.02	0.83	1.85	0.96	2.99	3.55
PROB	0.0113	0.235	0.188	0.230	0.0705	0.203	0.00582	0.0162

## NORTHEAST OF LANDFILL (Area B)

	<u>Ba</u>	<u>Cd</u>	<u>Pb</u>	<u>Cr</u>	<u>Ni</u>	<u>Hg</u>	<u>As</u>	<u>Se</u>
mean	7.22	3.42	5.08	3.00	5.23	-1.14	2.87	-0.52
BK mean	4.43	0.45	3.12	2.61	2.78	-1.60	2.24	-0.67
variance	0.406	6.677	1.974	0.120	1.835	0.869	0.113	0.0411
BK VAR	0.338	1.302	0.186	0.0587	1.264	0.00163	0.908	0.00382
T	7.76	2.22	2.74	2.08	3.27	0.97	1.95	1.51
PROB	0.000343	0.0510	0.0332	0.0526	0.0130	0.201	0.0358	0.111

## WEST OF PONDS (Area F)

	<u>Ba</u>	<u>Cd</u>	<u>Pb</u>	<u>Cr</u>	<u>Ni</u>	<u>Hg</u>	<u>As</u>	<u>Se</u>
mean	5.71	1.12	4.36	2.96	3.99	-1.41	2.85	-0.69
BK mean	4.43	0.45	3.12	2.61	2.78	-1.60	2.24	-0.67
variance	0.141	0.0389	0.309	0.145	0.277	0.0602	0.0543	0.000000
BK VAR	0.338	1.302	0.186	0.0587	1.264	0.00163	0.908	0.00382
T	5.07	1.94	4.06	1.74	2.90	1.53	2.04	1.10
PROB	0.000437	0.0378	0.00670	0.0801	0.00684	0.111	0.0307	0.148

## NORTH OF PONDS (Area G)

	<u>Ba</u>	<u>Cd</u>	<u>Pb</u>	<u>Cr</u>	<u>Ni</u>	<u>Hg</u>	<u>As</u>	<u>Se</u>
mean	4.77	1.90	3.36	2.92	3.39	-1.38	2.87	-0.34
BK mean	4.43	0.45	3.12	2.61	2.78	-1.60	2.24	-0.67
variance	0.0265	0.507	0.0182	0.00455	0.0200	0.219	0.154	0.0802
BK VAR	0.338	1.302	0.186	0.0587	1.264	0.00163	0.908	0.00382
T	1.84	2.99	1.72	4.03	1.85	0.95	1.86	2.31
PROB	0.0439	0.00800	0.0537	0.000628	0.0449	0.206	0.0430	0.0507

clay in the cap, which could easily have a different lead content than the background samples. Due to the off site origin of the clay, this data set will be eliminated from further discussion.

As mentioned above, a probability value less than 0.05 shows a significant difference between a test area and the background area. A significant difference was observed for the following:

- North of the landfill (Area C) for barium, arsenic, lead, and selenium.
- Northeast of the landfill (Area B) for barium, cadmium, lead, nickel, and arsenic.
- West of the ponds (Area F) for barium, cadmium, lead, nickel, and arsenic.
- North of the ponds (Area G) for barium, cadmium, chromium, nickel, and arsenic.

The appearance of barium, cadmium, and lead is not surprising given that wastes in those areas reportedly contain these hazardous constituents. The appearance of nickel, arsenic, chromium, and selenium is unexpected and could be attributed to the corrosion of process equipment, the concentration of these constituents in the brine used in the processes, and raw water obtained from Lake Erie containing these constituents.

In addition to analysis of the eight metals, a priority pollutant scan was conducted on sample SS5-2 (collected from Area G). There were no detectable amounts of volatile organic compounds, acid extractable compounds, base neutral compounds, pesticides, PCBs, phenols, or cyanide. Other metals were detected, however, including zinc (123 ppm), beryllium (1.5 ppm) and copper (30.3 ppm).

#### 6.2.2 Deep Soil

The split spoon soil samples from the borings and wells were analyzed, at a wide range in depths, for total cyanide, lead, barium, cadmium, nickel,



arsenic, selenium, mercury, silver, and chromium. Only samples from deep well borings were analyzed if a well couplet existed; otherwise, samples collected from shallow wells were analyzed. An exception is well 9D in which a sample collected from 9S (collected at 10 ft depth) was analyzed in lieu of a sample from 9D (there was no soil sample recovery at this depth for well 9D). Figure 3-1 shows the locations of the boreholes and wells. The analytical results for these deep soils are presented in Appendix 9.

Table 6-4 summarizes the deep soil data by averaging metal concentrations by depths for background and each SWMU. Anomalously high metal concentrations, compared to background values (wells 9S/9D, 10S, and 11D), were observed in soils from borings SB-16 and SB-17 and well 8S (Area G). These deep soils exhibited high values for lead, barium, cadmium, and nickel at depths from 0.5 to 3.3 ft below land surface but not deeper than 6.5 ft. In addition, deep soils from Area D (wells 5D and 6S) exhibited high values for lead, barium, and nickel at depths from 3.0 to 6.5 ft below land surface.

The subsurface soils generally have higher concentrations of these constituents than surficial soils in the vicinity of the five active ponds and adjacent fill areas (Areas D, F, and G). In the fill areas northeast and northwest of the landfill (Areas B and C), the opposite is true. The surficial soils exhibit much higher concentrations of these metals than the subsurface soils. Therefore, it is apparent that the SWMUs in the vicinity of the ponds (Areas D, F, and G) were used as fill areas and have since been graded over with non-fill materials; and the SWMUs in the vicinity of the closed landfill (Areas B and C) were used as temporary surficial storage zones for material that was later placed into the landfill.

In addition to the analysis of the eight metals, a priority pollutant scan was conducted on samples 8S (6.5 ft), 1S (15.1 ft), and 2S (6.0 ft). Volatile organic, base neutral, and acid extractable compounds were only detected in samples from 1S and 2S and these are subsequently discussed in Section 6.6 of this report. Copper and zinc were the only additional metals detected in soil samples from 8S (24.5 and 70.0 ppm respectively), 1S (20.5 and 59.9 ppm respectively), and 2S (22.2 and 60.5 ppm, respectively).

TABLE 6-4  
DEEP SOIL DATA  
AVERAGED BY DEPTH<sup>a</sup>

Area	Depth Range (ft)	Metals (mg/kg)									Total Cyanide
		Pb	Ba	Cd	Ni	As	Se	Hg	Ag	Cr	
Background (Wells 9S/9D, 10S, 11D)	1.0 - 5.0	29.9	67.2	BMDL <sup>b</sup>	14.5	22.8	0.66	BMDL	BMDL	15.9	0.10
	9.7 - 10.9	BMDL	98.8	BMDL	22.1	16.5	BMDL	BMDL	BMDL	19.0	BMDL
	14.5 - 19.5	BMDL	73.2	BMDL	21.0	18.7	BMDL	BMDL	BMDL	18.2	BMDL
	56.5 - 57.0	BMDL	BMDL	BMDL	29.3	16.4	BMDL	BMDL	BMDL	20.6	BMDL
A: Closed Landfill (Wells 1S, 2S, 3S, 4D)	3.5 - 6.0	16.0	67.5	BMDL	14.9	14.5	BMDL	BMDL	BMDL	14.6	BMDL
	9.5 - 17.0	15.5	60.5	3.95	17.1	14.9	BMDL	0.24	BMDL	15.8	BMDL
	21.0 - 24.5	15.6	52.1	BMDL	19.8	13.7	BMDL	BMDL	BMDL	15.1	BMDL
	46.2 - 46.7	BMDL	54.0	BMDL	25.9	19.1	BMDL	BMDL	BMDL	19.7	BMDL
B,C: Fill Areas North Closed Landfill (Borings SB11, SB12, SB13)	0.8 - 3.0	15.6	92.5	BMDL	7.5	20.8	0.75	BMDL	BMDL	9.6	0.12
	7.5 - 11.5	15.6	47.9	BMDL	14.2	19.4	BMDL	BMDL	BMDL	14.3	0.11
	28.0 - 29.5	15.6	39.2	BMDL	14.2	15.6	BMDL	BMDL	BMDL	13.5	0.14
D: Former Fill Areas In Vicinity of Wastewater Treatment Ponds (Wells 5D, 6S)	3.0 - 6.5	37.4	524.8	BMDL	87.2	20.8	BMDL	BMDL	BMDL	18.7	BMDL
	13.3	BMDL	72.1	BMDL	19.3	20.4	BMDL	BMDL	BMDL	17.6	BMDL
	56.5 - 57.0	BMDL	36.0	BMDL	25.9	20.8	BMDL	BMDL	BMDL	19.7	BMDL
F: Fill Areas West of Wastewater Treatment Ponds (Well 7D, Borings SB14, SB15)	0.5 - 1.7	BMDL	40.5	1.10	11.3	17.7	0.86	BMDL	BMDL	10.1	BMDL
	8.5 - 14.5	15.4	48.9	BMDL	19.2	15.5	BMDL	BMDL	BMDL	15.7	BMDL
	29.5 - 30.0	BMDL	26.0	BMDL	18.5	20.0	BMDL	0.25	BMDL	15.0	BMDL
	57.6 - 58.1	BMDL	BMDL	BMDL	27.6	22.7	BMDL	BMDL	BMDL	20.6	BMDL
G: Fill Areas North of Wastewater Treatment Ponds (Well 8S, Borings SB16, SB17)	0.5 - 3.3	189.9	1,396.0	85.2	156.6	17.2	BMDL	0.51	3.40	35.2	BMDL
	6.5	BMDL	72.1	BMDL	22.6	18.9	BMDL	BMDL	BMDL	16.7	BMDL
	17.3 - 18.0	21.1	162.0	3.10	11.3	20.1	BMDL	BMDL	BMDL	11.9	BMDL
	29.5 - 30.0	BMDL	63.1	BMDL	20.9	16.3	BMDL	BMDL	BMDL	16.3	BMDL
Detection Limits		15.0	25.0	1.00	5.0	1.0	0.50	0.20	1.5	2.5	0.10

<sup>a</sup>If an analytical result was below the method detection limit (BMDL) the value of the detection limit was used in averaging.

<sup>b</sup>BMDL = below method detection limit.



The metal concentrations were compared to EP Toxicity Equivalent factors (EP Toxicity Maximum Contaminant Concentration (MCC) multiplied by the analytical dilution factor of 20). This comparison is shown as Table 6-5. The EP Toxicity Equivalent factor is a "worst case" value and materials that do not contain chemicals in excess of the factors could not possibly be EP toxic, even if 100 percent of the chemicals were leachable.

Only two samples exceeded the EP Toxicity Equivalent: soil boring SB-16 (0.5 to 3.0 ft) and soil boring SB-17 (1.6 to 3.3 ft). These soil samples exceeded the EP Toxicity equivalent for lead and cadmium. EP Toxicity tests were then performed on these samples to determine if the samples actually exceed the EP Toxicity limits for lead and cadmium (Appendix 9). The results established that the soils from the two boreholes in question are not EP Toxic.

### 6.3 SURFACE WATER AND SEDIMENT

#### 6.3.1 Wastewater Treatment Pond System

Based upon available current and historical data for the waste types received by the SWMUs being investigated as a part of this RFI, several constituents are expected to be present in the vicinity of the five wastewater treatment ponds. Section 5.3.1 is a summary identifying these waste constituents. Chromium, lead, selenium, and silver were detected at trace levels in samples from the french drains. In addition, barium, cadmium, and lead are constituents suspected to have been in the solid wastes originally disposed of in the landfill areas in the vicinity of the ponds and west of the ponds. As such, barium, cadmium, chromium, lead, selenium, and silver were determined to be the primary constituents potentially present in the ponds and in the subsurface near the ponds. Therefore, these constituents were considered the main parameters of concern for chemical analyses.

Analytical results for the waters in the five wastewater treatment ponds (PW) are summarized in Table 6-6. The samples have been labeled according to the

TABLE 6-5

## DEEP SOIL METALS - EP TOXICITY COMPARISON

Metal	EP Toxicity Maximum Contaminant Concentration <sup>a</sup> (mg/l)	EP Toxicity Equivalent <sup>b</sup> (mg/l)	Samples Exceeding Equivalent (depth in ft)	Samples Failing EP Toxicity Test
Pb	5	100	SB-16 (0.5-3) SB-17 (1.6-3.3)	None
Ba	100	2,000	None	--
Cd	1	20	SB-16 (0.5-3) SB-17 (1.6-3.3)	None
Ni	None	None	None	--
As	5	100	None	--
Se	1	20	None	--
Hg	0.2	4	None	--
Ag	5	100	None	--
Cr	5	100	None	--

<sup>a</sup>As specified in 40 CFR 261.24: Characteristic of EP Toxicity.

<sup>b</sup>EP Toxicity Equivalent is equal to the EP Toxicity Maximum Contaminant Concentration multiplied by 20.



TABLE 6-6

SURFACE WATER ANALYTICAL RESULTS FOR THE  
WASTEWATER TREATMENT PONDS<sup>a</sup>

Parameter	Detection Limit	PW 1	PW 2	PW 3	PW 4	PW 5	PW <sup>d</sup> 6	PW <sup>e</sup> 7
Arsenic	1.0	BMDL <sup>b</sup>	BMDL	BMDL	1.5	BMDL	BMDL	BMDL
Barium	500	870	770	5,500	1,900	1,600	BMDL	4,400
Cadmium	1.0	3.4	4.3	11.4	2.0	11.1	BMDL	1.7
Chromium	5.0	44.0	59.8	BMDL	BMDL	7.3	BMDL	BMDL
Lead	2.0	BMDL <sup>c</sup>	BMDL <sup>c</sup>	2.8	BMDL	BMDL	BMDL	2.4
Mercury	0.4	4.2	13.2	1.8	1.4	BMDL	BMDL	BMDL
Selenium	1.0	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL
Silver	1.0	BMDL	1.1	BMDL	BMDL	BMDL	BMDL	BMDL
pH (units)	--	12.0	11.7	11.8	11.7	11.8	7.55	11.6
TOC (ppm)	2.0	5.5	4.5	4.2	3.6	3.9	BMDL	4.0

<sup>a</sup>All results expressed in ppb unless otherwise specified.<sup>b</sup>BMDL = Below method detection limit.<sup>c</sup>Detection limit is increased 5 times due to sample matrix.<sup>d</sup>Field blank.<sup>e</sup>Blind duplicate of PW-3.

pond from which they were collected. Sample PW-6 is the field blank and PW-7 was a blind duplicate of PW-3 for this sampling subtask. Low total organic carbon (TOC) values were found in these samples, ranging from 3.6 ppm to 5.5 ppm.

There appears to be no distinguishable pattern to the detectable concentrations. The data presented in Table 6-6 indicate that arsenic, lead, selenium, and silver were not detected in any sample appreciably above detection limits. Barium and cadmium were detected in samples from all five ponds. Chromium and mercury were detected in three and four samples, respectively, from the five ponds. The ranges of concentrations for these metals were less than an order of magnitude for barium (770 ppb to 5,500 ppb) and cadmium (1.7 ppb to 11.4 ppb), but greater than an order of magnitude for chromium (BMDL to 59.8 ppb) and mercury (BMDL to 13.2 ppb). The pH values for all five samples and the duplicate were consistent, ranging from 11.6 to 12.0 standard units.

Chromium was detected in appreciable concentrations in Ponds 1 and 2 only. This is reasonable as chromium is one of the constituents in the french drain waters. Most of the wastewater treatment and sedimentation occurs in Ponds 1 and 2, and reportedly, all of the influent to the pond system is discharged into those two ponds. Barium was detected in appreciable concentrations in all five ponds. Barium is a constituent of the wastewater which flows into the ponds. Mercury was detected in Ponds 1, 2, 3, and 4 at an appreciable concentration in Pond 2 only. Mercury is not reported to be a constituent of any of the wastes currently or previously placed in or near the ponds. As such, the source of the mercury is unknown, but may be present in low concentrations in raw materials (i.e., water supply or brine solution) used at the plant.

Analytical data for the five pond sediment (PS) samples are summarized in Table 6-7. The samples are labeled according to the pond from which they were collected. Sample PS-6 is a duplicate of sample PS-3. As with the pond surface water, metals were the main parameters of concern for this media.



TABLE 6-7

ANALYTICAL RESULTS FOR WASTEWATER TREATMENT  
POND SEDIMENTS<sup>a</sup>

Parameter	Detection Limit	PS 1	PS 2	PS 3	PS 4	PS 5	PS 6 <sup>c</sup>
Arsenic	5.0	BMDL <sup>b</sup>	BMDL	BMDL	BMDL	BMDL	BMDL
Barium	20.0	1,280	31.5	1,420	3,020	2,500	510
Cadmium	1.0	BMDL	BMDL	BMDL	BMDL	BMDL	2.1
Chromium	2.5	17.5	6.1	7.6	5.5	4.2	10.0
Lead	1.0	9.2	2.9	6.7	2.9	3.8	9.0
Mercury	0.20	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL
Selenium	0.50	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL
Silver	0.05	0.22	BMDL	0.18	0.23	0.14	0.21
pH (units)	--	10.8	11.4	10.7	10.9	10.8	9.79
% Solids	--	49.5	46.6	35.3	45.1	58.2	37.4
% Volatile Solids	--	3.0	3.4	1.8	2.5	2.3	1.9

<sup>a</sup>All results expressed in mg/kg (ppm), wet weight.<sup>b</sup>BMDL = Below method detection limit<sup>c</sup>Blind duplicate of PS-3.

This is corroborated by the low percent volatile solids detected in the samples. These percentages ranged from 1.8 to 3.4 percent. The inorganic portion of these sediment samples constitutes approximately 96 percent or more of the samples.

Arsenic, mercury, and selenium were not found in any of the sediment samples in detectable concentrations. Cadmium was only found in one sample, the duplicate, at a detectable level. Lead and silver were detected in nearly all sediment samples but in relatively low concentrations (2.9 mg/kg to 9.2 mg/kg and BMDL to 0.23 mg/kg, respectively). As such, only barium and chromium were detected in appreciable concentrations. Barium concentrations varied considerably, ranging from 31.5 mg/kg to 3,020 mg/kg - nearly two orders of magnitude. The chromium concentrations ranged less than an order of magnitude, from 4.2 mg/kg to 17.5 mg/kg, with the maximum concentration (17.5 mg/kg) measured in sample PS-1. Because chromium concentrations measured were low, chromium does not appear to be in the pond sediment at levels of potential concern. As with the pond water, pH values of the sediment were very consistent, with values ranging from 9.8 to 11.4 standard units.

Based upon the data presented in Table 6-7, barium appears to be the only parameter detected in the pond sediments at concentrations of possible concern. As discussed previously for the pond water, barium can be expected to occur in association with the pond system due to its presence in influent wastewaters and the presence of barium in relatively high concentrations in the sediment is reasonable.

Water from the four collection manholes (MHW) for the french drain were analyzed for the same parameters of concern as for the wastewater treatment ponds. Table 6-8 is a summary of these data. Water samples from the manholes are labeled according to the wastewater treatment pond near which they are located. As such, MHW-1 is from the manhole located southwest of Pond 1, MHW-2 is from the manhole southeast of Pond 2, MHW-4 is from the manhole northeast of Pond 4, and MHW-5 is from the manhole located west of Pond 5.



TABLE 6-8

ANALYTICAL RESULTS FOR WATER COLLECTED FROM  
THE FRENCH DRAIN SYSTEM<sup>a</sup>

Parameter	Detection Limit	MHW 1	MHW 2	MHW <sup>d</sup> 3	MHW 4	MHW 5	MHW <sup>e</sup> 6
Arsenic	1.0	2.7	2.4	BMDL <sup>b</sup>	BMDL	BMDL	BMDL
Barium	500	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL
Cadmium	1.0	1.8	2.9	BMDL	10.9	26.8	2.7
Chromium	5.0	11.0	BMDL	BMDL	BMDL	BMDL <sup>c</sup>	6.2
Lead	2.0	11.0	11.0	BMDL	2.3	BMDL	19.0
Mercury	0.4	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL
Selenium	1.0	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL
Silver	1.0	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL
pH (units)	--	6.22	6.09	7.33	6.37	6.22	7.02
TOC (ppm)	2.0	14.0	7.4	BMDL	5.7	3.1	7.3

<sup>a</sup>All results expressed in ppb unless otherwise specified.<sup>b</sup>BMDL = Below method detection limit<sup>c</sup>Detection limit is increased 5 percent due to sample matrix.<sup>d</sup>Field blank.<sup>e</sup>Blind duplicate of MHW-2.

MHW-3 is a field blank and MHW-6 is a blind duplicate of MHW-2. Metals were considered to be the parameters of concern for this media due to the intended design purpose of the french drain. The french drain is intended to collect water leaking from the wastewater treatment ponds. The french drain will also collect localized shallow groundwater due to inherent design functions for french drains. Metals have been determined to be the parameters of concern for the ponds and the groundwater. The TOC levels for these samples are relatively low, ranging from 3.1 ppm to 14.0 ppm, thereby again corroborating that organics are not a concern.

Barium, mercury, selenium, and silver were not detected at levels above detection limits. Arsenic, chromium, and lead were found in quantifiable concentrations, but these are relatively low, with an overall quantifiable range of 2.3 ppb to 19.0 ppb. As such, only cadmium was detected in the water in the manholes in appreciable concentrations (BMDL to 26.8 ppb). The pH values of the water in the manholes was quite consistent. However, the values were appreciably lower than those in the ponds, ranging from 6.09 to 7.33 standard units.

The analytical data for the water in the collection manholes indicate results generally similar to those summarized for the pond water and sediment and the shallow groundwater near the ponds. Barium was detected in appreciable quantities in both the pond water and sediment, and mercury in the pond water but not the sediment. In addition, barium and cadmium have been detected in the shallow groundwaters in the vicinity of the french drain. Because the french drain will collect both water from the wastewater treatment ponds and from the shallow groundwater zone, it is reasonable that the waters in the manholes exhibit characteristics of each. However, different parameters exhibit different attenuation properties, therefore, not all parameters detected in the groundwater and/or the ponds would necessarily be present in the water collected by the french drain. Therefore, the concentrations of cadmium in the manhole water may be attributed to both the pond water and the local shallow groundwater. Additionally, the cadmium and relatively low concentrations of lead may, in part, be leaching from the former fill areas in the vicinity of the wastewater treatment ponds.



One trend in the analytical data for the water from the french drain is that concentrations for most parameters for MHW-5 are the highest for the four manhole samples. Specifically, these parameters include cadmium; the major ions calcium, magnesium, sodium, and bicarbonate; total dissolved solids (TDS); conductivity; sulfate; and chloride. In particular, sodium, TDS, conductivity, and chloride concentrations in the water from the manhole near Pond 5 are all an order of magnitude greater than those for the other four manholes. Some of these concentrations are comparable to those found in the shallow groundwater.

#### 6.3.2 Site Drainage System

Surface waters from seven locations in the drainage ditch system on the southern portion of the RMI property were sampled (DW). Analytical results are summarized in Table 6-9. Locations for these surface water samples are presented on Figure 3-1. Sample DW-H is a field blank and samples DW-I and DW-J are blind duplicates of DW-G and DW-C, respectively.

The ditch system in this area of the RMI property intercepts a portion of the shallow groundwater in the vicinity. Due to the information available regarding present and historical waste disposal practices, metals were again considered to be the parameters of concern. However, two priority pollutant scans were also performed (DW-E and DW-G) because organics (believed to be migrating from off site sources) were detected in groundwater and soil samples in the vicinity of the RMI southern property line. Analytical results for the organic priority pollutant scans are summarized such that only detected concentrations are presented in Table 6-9. (The priority pollutant organic scan for DW-G was not duplicated by the analyses for DW-I). Ditch sample locations E and G were chosen, in part, because they represent areas on RMI property where segments of the drainage ditch flow onto and off, respectively, RMI property along the southern property border. As such, flow of potentially contaminated surface water in the ditch onto and off the property can be partially evaluated utilizing these data.

TABLE 6-9  
DRAINAGE DITCH SURFACE WATER ANALYTICAL RESULTS<sup>a</sup>  
RMI COMPANY - SODIUM PLANT

Parameter	Detection Limit	DW A	DW B	DW C	DW D	DW E	DW F	DW G	DW <sup>e</sup> H	DW <sup>f</sup> I	DW <sup>g</sup> J
Antimony	200	NA <sup>b</sup>	NA	NA	NA	BMDL <sup>c</sup>	NA	BMDL	NA	NA	NA
Arsenic	1.0	NA	NA	NA	NA	BMDL	NA	1.8	NA	NA	NA
Barium	500	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL
Beryllium	20	NA	NA	NA	NA	BMDL	NA	BMDL	NA	NA	NA
Cadmium	1.0	1.9	37.9	BMDL	BMDL	BMDL	3.1	2.1	BMDL	2.6	BMDL
Chromium	5.0	NA	NA	NA	NA	BMDL	NA	BMDL	NA	NA	NA
Copper	20	NA	NA	NA	NA	BMDL	NA	BMDL	NA	NA	NA
Lead	2.0	3.7	BMDL	BMDL	3.6	4.9	3.8	3.6	BMDL	2.0	3.1
Mercury	0.4	NA	NA	NA	NA	BMDL	NA	BMDL	NA	NA	NA
Nickel	100	NA	NA	NA	NA	BMDL	NA	BMDL	NA	NA	NA
Selenium	1.0	NA	NA	NA	NA	BMDL	NA	BMDL	NA	NA	NA
Silver	1.0	NA	NA	NA	NA	BMDL	NA	BMDL	NA	NA	NA
Thallium	200	NA	NA	NA	NA	BMDL	NA	BMDL	NA	NA	NA
Zinc	10	NA	NA	NA	NA	359	NA	77	NA	NA	NA
Cyanide (ppm)	0.02	NA	NA	NA	NA	BMDL	NA	BMDL	NA	NA	NA
Phenol (ppm)	0.05	NA	NA	NA	NA	BMDL	NA	BMDL	NA	NA	NA
pH (units)	--	6.56	7.16	7.50	7.35	6.27	6.97	6.51	7.93	6.31	6.55
TOC (ppm)	2.0	6.5	7.0	5.0	4.8	48.2	7.5	10.0	BMDL	9.6	8.5
Chloroform	1.0	NA	NA	NA	NA	ND <sup>d</sup>	NA	5.5	NA	NA	NA
1,1,2,2-Tetrachloroethane	1.0	NA	NA	NA	NA	ND	NA	BMDL	NA	NA	NA
1,2-Trans-Dichloroethylene	1.0	NA	NA	NA	NA	37.9	NA	10.0	NA	NA	NA
1,1,2-Trichloroethane	1.0	NA	NA	NA	NA	ND	NA	2.6	NA	NA	NA
Trichloroethylene	1.0	NA	NA	NA	NA	ND	NA	2.6	NA	NA	NA
Trichlorofluoromethane	1.0	NA	NA	NA	NA	2.9	NA	12.7	NA	NA	NA

<sup>a</sup>All results expressed in ppb unless otherwise specified.

<sup>b</sup>NA = Not analyzed.

<sup>c</sup>BMDL = Below method detection limit.

<sup>d</sup>ND = Not Detected.

<sup>e</sup>Field blank.

<sup>f</sup>Blind duplicate of DW-G.

<sup>g</sup>Blind duplicate of DW-C.



An indication of the presence of organics exists in the ditch water samples. Sample DW-E, which is located near one of the groundwater monitoring wells in which organics were detected, had a TOC concentration of 48.2 ppm, well above the TOC levels for all of the other ditch sample locations. The other six samples had TOC levels ranging from 4.8 ppm to 10.0 ppm.

The data summarized in Table 6-9 indicate that the majority of the metals found in the ditch water in detectable concentrations are at relatively low levels. No barium was detected in quantifiable concentrations in any of the samples. Lead was found in quantifiable levels in most of the samples, but at relatively low concentrations (BMDL to 4.9 ppb). The highest concentration was detected in water upgradient for the RMI property. Cadmium, the only other metal analyzed in all seven ditch water samples, was found at a concentration of potential concern in only one sample, DW-B (37.9 ppb). The other sample locations contained cadmium in concentrations ranging from BMDL to 3.1 ppb. The pH values for the ditch water samples are again shown to be consistent, ranging from 6.27 to 7.50 standard units (the high pH value of 7.93 standard units is associated with the field blank).

The metals analyses for the two samples (DW-E and DW-G) for which priority pollutant scans were performed, resulted in detectable concentrations for arsenic (1.8 ppb), and zinc (359 ppb and 77 ppb). The zinc concentrations are the only ones that appear to be appreciable. No antimony, beryllium, copper, mercury, nickel, selenium, silver, thallium, cyanide, or phenol were found above detection limits in either sample. No base neutral or acid extractable compounds were detected in either of the organic priority pollutant scans. Additionally, no pesticides or PCBs were detected in either of the scans. However, six volatile organic compounds were found in detectable levels in at least one of the two samples, of which one parameter (1,1,2,2-tetrachloroethane) was found in one sample at a concentration below the detection limit. Complete laboratory analytical reports are included in Appendix 9. Only two parameters were found in both samples: 1,2-trans-dichloroethylene (37.9 ppb and 10.0 ppb) and trichlorofluoromethane (2.9 ppb and 12.7 ppb).

Because RMI does not produce organic materials or use organics as a part of their process (nor have they in the past), organics are not expected to be detected in any on site media. Therefore, the volatile organic compounds detected in the two priority pollutant scans for DW-E and DW-G are believed to originate from an off site source. This is discussed further and in more detail in Section 6.6. Also, the presence of zinc in sample DW-E suggests a potential off site source. This possibility is supported by the location of DW-E. Although zinc has been detected in subsurface soils in the vicinity of the closed landfill (wells 1S and 2S), sample DW-E represents a portion of the ditch system as it flows onto the RMI property and is located upgradient of the closed landfill.

The relatively high cadmium concentration at only location DW-B suggests a separate, potentially local source. Cadmium was detected in the surficial soils at the fill area northeast of the closed landfill. Topographic maps of this area indicate stormwater runoff from the fill area flows to the ditch system near DW-B. As such, the cadmium may be entering the ditch system near DW-B via stormwater runoff.

A remedial investigation has been conducted by USEPA for the Fields Brook Superfund site. This investigation included sampling of the DS tributary surface water and/or sediment at three locations on or near RMI property. These data may be used in conjunction with the analytical results from this RFI sampling effort. Data from the remedial investigation are included and discussed in Sections 4.4.1 and 4.4.4.

Surface water data from the remedial investigation is available at only one sample location in the vicinity of the RMI property (Ø24). This sample location is downstream of RMI property and, therefore, direct comparison of analytical data is not possible. However, the list of parameters detected in the surface water sample during the remedial investigation generally resembles the list detected in the ditch water for this RFI. In both instances, barium;



cadmium; mercury; 1,1,2-trichloroethane; 1,1,2,2-tetrachloroethane; 1,2-trans-dichloroethene; and trichloroethene were detected. The only discrepancies are that boron, iron, manganese, methylene chloride, and tetrachloroethene were detected during the remedial investigation but not during the RFI. However, boron, iron, and manganese were not analyzed for during the RFI. Conversely, zinc, chloroform, and trichlorofluoromethane were detected during the RFI but not during the remedial investigation. Trichlorofluoromethane does not appear to have been included in the list of parameters for the remedial investigation.

Analytical data from the remedial investigation for sediment in the DS tributary is available for three locations, sample numbers 024, 213, and 214. These data indicate that a number of organic and inorganic parameters were detected in the sediment at these locations. All of the parameters detected in concentrations above the detection limit in the one surface water sample of interest for the remedial investigation were also detected in the sediment samples with the exceptions of 1,1,2-trichloroethane and mercury which were not analyzed for that sediment sample. As discussed in Section 4.4.4, the highest concentrations of inorganic parameters were found in samples collected from station number 214 with the exception of aluminum, chromium, iron, vanadium, and antimony.

#### 6.4 AIR

Ambient air monitoring for total organic vapors and gases was conducted using an HNU photoionizer during groundwater and surface water sampling, drilling and installation of monitoring wells, and surficial soil sampling. No measurements of ambient air above background levels were observed.

Although no air monitoring has been conducted for metals, it is possible that small quantities of metals sorbed onto the surficial soils may migrate via fugitive dust. This transport mechanism would only be expected in areas where metals are known to be present in the surficial soil in appreciable concentrations, i.e., the fill areas northeast and northwest of the closed landfill and the fill areas west and north of the wastewater treatment ponds.

## 6.5 SUBSURFACE GAS

Only metals have been identified as waste constituents of concern of the RMI Sodium Plant SWMU's. Because the metals of concern are not volatile, the production and release of subsurface gases is unlikely. In addition, the type of wastes disposed in the SWMU's do not decompose in a manner which would contribute to methane or other types of gas production. Therefore, subsurface gas releases will not be further considered in the RFI.

## 6.6 ORGANIC CONTAMINANTS FROM OFF SITE SOURCES

A dense non-aqueous phase liquid (DNAPL) has been observed in the subsurface, on the extreme southern portion of the RMI Sodium Plant site in the vicinity of the closed landfill. A DNAPL is an organic chemical which is liquid at normal temperatures, is generally immiscible in water, and has a density greater than that of water. The DNAPL at this site, as in most instances, is composed of chlorinated solvents. The following presents historical and recent observations of DNAPL; identification of a potential off site source of DNAPL, and the occurrence of DNAPL and related dissolved constituents in the groundwater, soil, surface water, air, and subsurface gas at the RMI site.

### 6.6.1 Background

On September 30, 1981, leachate was observed in the ditch south of the closed on site landfill. The observation was made by Mr. Larry Hanek and Mr. Joseph Holman of RMI Company and Ms. Chris Khourey, Mr. Gary Gifford, and Ms. Melinda Merryfield-Becker of Ohio EPA. Several pools of a dark red liquid in the bottom sediments of the drainage ditch were reported. A strong odor likened to chlorinated organics was present in the area. This sighting was reported in a letter from Melinda Merryfield-Becker to J. T. Holman dated October 15, 1981. The ditch was capped with clay after the dark red liquid was observed in the bottom of the ditch creating a shallower ditch. No conclusion as to the ultimate source of this apparent leachate was made. Analysis of samples



taken indicated the presence of chlorinated organics and the analytical data is included in Appendix 7.

On June 26, 1986, after a severe rain storm, leachate was observed seeping from the closed landfill site. A red-colored liquid was observed on the eastern side of the landfill. No odor was present. The flow of leachate ceased within a relatively short period of time. These observations were made by Mr. Ben A. DiRienzo, Plant Manager; Mr. Joseph T. Holman, Manager - Environmental Control; Mr. B. J. Baughman, Manager - Engineering; Ms. Francine Norling, U.S. EPA Region V; and Ms. Christine Frazier, Ohio EPA. The clay cap was repaired.

On August 18, 1988, the presence of volatile organic compounds were detected with the HNU photoionizer during the drilling of piezometers PZ-8 and PZ-9. PZ-8 is located on the southern edge of the closed landfill and PZ-9 is located in the center of the landfill. A small amount of volatile organics (approximately 2 ppm) were detected with the HNU in PZ-9 only at a depth of 19 ft compared to 15 ppm at a depth of 10 ft in piezometer PZ-8 adjacent to the southern edge of the landfill. Therefore, the first indications of volatile organics were below the fill material comprising the landfill which eliminates the landfill as a potential DNAPL source.

On October 19, 1988, the presence of volatile organics were detected with the HNU during the drilling of well 2S (10 ft east of PZ-8). A dark red liquid, presumed to be chlorinated solvents, was encountered in the sandy till zone at approximately 16 ft below land surface. To prevent the potential downward migration of these solvents, it was determined to complete well 2S as a shallow well and not a bedrock well (2D) as was originally planned. On October 24, 1988, the presence of volatile organics were detected with the HNU during the drilling of well 1S (approximately 400 ft west of 2S). Droplets of a dark red liquid, again presumed to be chlorinated solvents, were encountered in the sandy till zone at approximately 17 ft below land surface. Once again, it was determined to complete well 1S as a shallow well and not as a bedrock well (1D). The dark red DNAPL encountered in the sandy till is not similar to

the red liquid found on the landfill in June 1986. However, it is very similar to the dark red liquid observed on September 1981 in the drainage ditch (see Section 5.2.1.1). There is no indication that the DNAPL is associated with the landfill. The chlorinated solvents observed in the ditch (1981) probably originated from off site surface water discharges to the ditch.

RMI does not, and has never used chlorinated solvents at the Sodium Plant. The Sodium Plant site is restricted and has extensive security devices, therefore, it is extremely unlikely that these chemicals were illegally or inadvertently dumped into the landfill in the past. Therefore, it is presumed that the chemicals migrated from an off site source.

#### 6.6.2 Groundwater

Monitoring wells 1S, 2S, 4S, and 4D (sampled November 21, 1988) and wells 3S, 4S, and 4D (sampled January 16, 1989) were subjected to a GC/MS organic priority pollutant scan because of the observation of a DNAPL in the groundwater on the southern portion of the RMI site. A summary of detected constituents is found in Table 6-10 and all groundwater laboratory results are located in Appendix 9.

As was previously mentioned, DNAPLs are organic chemicals (usually chlorinated solvents) which are generally immiscible in water and have a density greater than that of water. An estimated 10 ft thickness of a dark red DNAPL was observed in the bottom of well 2S. The DNAPL was analyzed and contains 3.3 percent 1,1,2,2-tetrachloroethane, 1.6 percent tetrachloroethylene, 2.3 percent trichloroethylene, and 1.8 percent hexachloroethane along with lesser amounts of some other volatile organic and base neutral compounds. In addition, beta-BHC and gamma-BHC pesticides were detected in appreciable quantities.

The DNAPL in well 2S appears to be confined to the sandy till zone from 16 to 21.5 ft below land surface (see Figures 4-8 and 4-9). The clay till above and below the sandy till zone would serve to confine the DNAPL within the sandy till due to its relatively low hydraulic conductivity. Schweille (1981) has



shown that the migration of free DNAPL in saturated sandy layers atop an aquitard is controlled exclusively by the slope of the aquitard and that the direction of flow of groundwater in the aquitard has virtually no impact upon DNAPL flow direction. Therefore, the accumulation of DNAPL in the sandy till zone is directly related to the geometry of the sandy till zone. Figure 6-3 shows the observed DNAPL and dissolved organics on the RMI site. It would appear based upon extrapolation of the data collected that the major portion of the sandy body and therefore, the DNAPL, occurs to the south of the RMI site.

The water level in well 2S was approximately 1 ft above ground surface (January 10, 1989), indicating an elevated piezometric head condition exists. Using a calculated DNAPL density of  $1.58 \text{ g/cm}^3$  and assuming a 10 ft DNAPL thickness, the corrected piezometric surface is approximately 7 ft above ground surface. However, while the water level measured in the well indicated a significant elevated head relative to surrounding wells, the DNAPL thickness was not measured in the field and, therefore, the DNAPL thickness and resultant corrected piezometric surface may actually be less. The DNAPL saturated sandy till zone behaves as a confined water bearing zone with a hydraulic head above land surface. This piezometric head condition was not observed in other groundwater wells on the RMI site. Therefore, it appears that the sandy till zone has been in contact with the DNAPL source south of the RMI site, and the extremely high density of the DNAPL combined with the isolation of the sandy till have caused a relatively high piezometric surface.

In addition to the DNAPL, the groundwater in well 1S contained relatively high concentrations of some volatile organic and base neutral compounds (Table 6-9). It appears that some dissolution of the pooled DNAPL has occurred and is present in well 1S. The groundwater in shallow wells 3S and 4S and in bedrock well 4D did not detect any volatile organic or base neutral compounds. Although it is possible for volatile organics to be present in the sandy till below wells 3S and 4S due to their configuration, there was no HNU response during the drilling of these wells above the sandy till as was the case while drilling 1S and 2S. In addition, during drilling of well 4D, the sandy till

was encountered and again there were no HNU readings above background. Based upon these data and the HNU readings while drilling piezometers PZ-8 and PZ-9, the occurrence of dissolved organic constituents is shown in Figure 6-3.

#### 6.6.3 Soil

Subsurface soils in boring 2S at 6 ft below land surface and boring 1S at 15.1 ft below land surface were subjected to a GC/MS organic priority pollutant scan because of the observation of a DNAPL in the subsurface on the southern boundary of the RMI site. A summary of detectable constituents is found in Table 6-10 and all soil laboratory results are located in Appendix 9.

The subsurface soil in boring 2S had detectable values of volatile organic and base neutral compounds. The soil in boring 1S had lower detectable values of volatile organic compounds. These results compare favorably with the groundwater analytical results in wells 2S and 1S, in which well 2S had DNAPL and well 1S had dissolved organic constituents. These soil samples were collected at depths shallower than the depth of the sandy till zone containing the DNAPL body. This indicates that some volatilization of the DNAPL and its dissolved constituents may have occurred, resulting in upward migration of these volatilized compounds. No significant downward migration is expected through the underlying low permeability clayey till.

#### 6.6.4 Surface Water

Surface water samples DW-E and DW-G were subjected to a GC/MS organic priority pollutant scan because of the observation of DNAPL in the subsurface. DW-E is located in the DS tributary of Fields Brook east of well 2S and DW-G is located in the DS tributary west of well 1S (Figure 3-1). A summary of detected constituents is found in Table 6-10 and all surface water laboratory results are located in Appendix 9.



The surface water at the DW-E location had trace amounts of 1,2-trans-dichloroethylene and trichlorofluoromethane and the surface water at DW-G had trace amounts of these compounds as well as trichloroethylene and 1,1,2-trichloroethane. These volatile organic constituents are not detected in the groundwater and subsurface soils at wells 1S and 2S with the exception of trichloroethylene. These volatile organics were most likely not detected in the groundwater and soils at wells 1S and 2S because the detection limits were elevated due to the high organic concentrations in the samples.

Fields Brook has been designated as a USEPA Superfund site and a remedial investigation conducted by the USEPA has determined that sections of Fields Brook and the DS tributary are contaminated by various organic compounds (USEPA 1985). As was discussed in Section 4.4.1, the RMI Sodium outfall to the DS tributary had no detectable amounts of volatile organics (see Table 4-7) and there is no reason to suspect that other sources of organics may exist on site as a result of RMI activities.

#### 6.6.5 Subsurface Gas and Air

The HNU photoionizer detected the presence of volatile organics in the subsurface during the drilling of wells 1S and 2S and piezometers PZ8 and PZ9 at depths as shallow as 3 ft below land surface. Therefore, it appears that some subsurface gas exists as a result of volatilization of the DNAPL and its associated dissolved constituents. Volatile organics do not appear to be present in the ambient air as indicated by zero readings on the HNU prior to drilling.

#### 6.6.6 Summary of Organic Contaminants

The dense non-aqueous phase liquid (DNAPL) comprised of chlorinated solvents, and its associated dissolved constituents, found on the RMI site are a result of an off site source located to the south. This conclusion is based on the following observations:

- RMI does not and has never used chlorinated solvents at the Sodium Plant. In addition, the plant security precautions would eliminate the potential for illegal or unintentional disposal of organics on site.
- A chemical manufacturing facility, located on the southern border of the site, has historically discharged chlorinated solvents to Fields Brook and settling lagoons on their property. The lagoons, located immediately adjacent to the RMI Sodium Plant property, were not lined and were used for storage of wastes from the manufacture of solvents. Surface water runoff from these lagoons was ultimately discharged to Fields Brook via drainage ditches. The documented wastes from these processes include trichloroethylene, chlorobenzene, tetrachloroethane, tetrachloroethylene, hexachlorobutadiene, and pentachloroethane. Several of these compounds were detected in elevated concentrations in the DNAPL from wells 2S and 1S and in the DS Tributary samples collected in 1981. The sources of this information were the Ohio EPA files, Northeast District Office, Twinsburg, Ohio and the USEPA CERCLA 104 Request for Information Response for the Fields Brook site.
- The DNAPL and its dissolved constituents have only been observed in the immediate vicinity of the southern boundary of the RMI property. The northernmost indication of organics was an HNU reading of 2 ppm at a depth of 19 ft in piezometer PZ-9. The only other wells and borings with detectable organic compounds were 1S, 2S, and PZ-8. This information further substantiates the conclusion that chlorinated solvents were not placed in the RMI landfill.
- The DNAPL has accumulated in a sandy till zone that extends off site to the south. There are two possible scenarios for the source of DNAPL. One very likely source is the unlined lagoons that could have discharged chlorinated solvents into the sandy layer through infiltration and seepage. The other potential source is the DS



Tributary to Fields Brook that could have received outfall discharges and lagoon runoff from the manufacturing facility located on the southern border of the RMI Sodium Plant. These would both result in the saturation of the sandy till by the DNAPL through time. The DNAPL movement is controlled by the geometry of the sandy till zone and, therefore, could migrate north under the RMI property.

#### 6.7 SUMMARY OF CONTAMINANT RELEASE

As previously discussed, the following environmental media were sampled for the metals expected to be found in the SWMU's investigated as part of this RFI:

- Groundwater in the shallow water-bearing zone and the bedrock water-bearing zone
- Surficial and deep soils
- Surface water (in wastewater treatment ponds and drainage ditches)
- Sediment (in wastewater treatment ponds)

The results of the surficial soil analyses were evaluated using the Student t statistical test at a 95 percent level of confidence. The analytical results for the other media sampled were evaluated by qualitative means. The results of the data evaluation indicate that several of the media sampled in areas associated with the SWMU's contain notable concentrations of the metals analyzed. A summary of the results of the sampling program is provided in Table 6-11.

At the RMI site, as in all environmental systems, interactions among the media will occur, creating pathways of migration for the metals of concern. The following is a discussion of potential migration pathways for the metals detected in areas associated with the various SWMU's.

TABLE 6-11

POTENTIAL SWMU AND MEDIA SOURCES FOR  
METALS OF CONCERN

SWMU	Surficial Soil <sup>a</sup>	Subsurface Soil <sup>b</sup>	Pond Water	Pond Sediments	French Drain Water	Drainage Ditch Water	Shallow Ground-water
A: Closed Landfill	None <sup>c</sup>	Zn				Zn	Ba, Cd
B: Fill Area Northeast of Closed Landfill	Ba, Cd, Pb, Ni, As	None				Cd	
C: Fill Area Northwest of Closed Landfill	Ba, As, Se, Pb	None				None	
D: Former Fill Areas in Vicinity of Wastewater Treatment Ponds		Pb, Ba, Ni	Ba, Cd, Hg	Ba	Cd		Ba, Cd
E: Wastewater Treatment Ponds			Ba, Cr, Hg	Ba	Cd		Ba, Cd
F: Fill Areas West of Wastewater Treatment Ponds	Ba, Cd, Pb, As, Ni	None			Cd		Ba, Cd
G: Fill Areas North of Wastewater Treatment Ponds	Ba, Cd, Cr, Ni, As, Zn	Pb, Ba, Cd, Ni					Ba, Cd

<sup>a</sup>Based on results of student t statistical test at 95 percent confidence level (see Section 6.2.1).<sup>b</sup>Metal presence principally confined to near surface sample intervals.<sup>c</sup>Clay cap.



#### 6.7.1 Closed Landfill (Area A)

Barium and cadmium were detected in the shallow groundwater in the vicinity of the closed landfill. As discussed in Section 4.2.2, a portion of groundwater in the vicinity of the closed landfill appears to discharge into the nearby drainage ditches and the DS tributary. Judging from the concentrations of metals in water samples from the ditches, metals contained in the drainage ditches appear to be sorbed to sediments, and have a low potential to migrate off site.

No metals were detected in notable concentrations in the surficial soil samples. However, this is not unexpected as the landfill has been closed with a clay cap. Zinc was detected in subsurface soil samples collected from 1S and 2S which were subjected to a priority pollutant scan. Zinc was also detected in the drainage ditch water in the vicinity of the closed landfill. It is unknown if zinc is present in the groundwater in this area as the groundwater samples were not subjected to the inorganic priority pollutant scan. It is possible that zinc present in the subsurface soils has leached into the groundwater which has subsequently discharged into the drainage ditch. However, zinc was also detected in drainage ditch samples upgradient of the landfill, indicating that zinc may also be migrating from an off site source.

#### 6.7.2 Fill Area Northeast of Closed Landfill (Area B)

In surficial soils collected from the fill area northeast of the closed landfill, barium, cadmium, lead, nickel and arsenic were found to be present in statistically significant concentrations as compared to background. No groundwater data are available for the area, but cadmium was detected in a ditch sample in the vicinity of this fill area (DW-B). It is likely that erosion of surficial soils from the fill area into the ditch has resulted in the presence of cadmium in the ditch. Groundwater from the shallow water bearing zone also discharges into the ditch. Water from this area will eventually reach the DS tributary and flow off site; however, cadmium contained in the ditch water is not expected to migrate off site because of

sorption onto the ditch sediments. This is corroborated by the low concentration of cadmium measured at sample location DW-G in the ditch system.

No metals were present in appreciable concentrations in the subsurface soil samples. This observation indicates that the waste materials were placed above ground, as has been reported by plant personnel, rather than buried and that metals present in the surficial soils have not leached into the subsurface soils.

#### 6.7.3 Fill Area Northwest of Closed Landfill (Area C)

In the fill area northwest of the closed landfill, barium, arsenic, lead, and selenium were present in statistically significant concentrations in the surficial soils as compared to background areas. No metals in appreciable concentrations were detected in the drainage ditch water (samples DW-A and DW-G) or subsurface soils (SB-11) near this SWMU. These observations indicate that the metals, if they have migrated into the drainage ditch, have not been transported to sample locations DW-A and DW-G. It is likely that any metals present have been sorbed onto sediments. The fact that the metals are not found in the subsurface soils also indicate that the waste materials were placed above ground, as has been reported by plant personnel, rather than buried and that the metals present in the surficial soils have not leached into the subsurface soils.

#### 6.7.4 Wastewater Treatment Ponds and Former Fill Areas in Vicinity of Wastewater Treatment Ponds (Areas D and E)

In the former fill area in the vicinity of the wastewater treatment ponds, metals were detected in several media. Barium, lead, and nickel were found in notable concentrations in the subsurface soils in these areas. Barium was also detected in the wastewater treatment pond water and sediments. Mercury was also detected in the pond water although reportedly was not placed into the former fill areas or ponds. In addition, chromium was detected in the pond water but this is not unexpected as chromium has been detected in the french drain waters.



In the shallow groundwater zone, barium and cadmium were detected in appreciable concentrations, probably the result of leaching of materials placed in the former fill areas. Cadmium was also detected in the french drain system. It is likely that the french drain system intercepts a portion of the groundwater containing cadmium in the vicinity of the wastewater treatment ponds.

It has been determined that further investigation of the area east of the wastewater treatment ponds is warranted. Additional study should include installation of additional piezometers and monitoring well to further define groundwater flow patterns and assess groundwater quality. Staff gages should also be installed in the eastern drainage ditch to better define surface flow characteristics in this area and to better determine the relationship between groundwater and surface water. Surface water samples should also be collected from the eastern ditch.

#### 6.7.5 Fill Areas West of Wastewater Treatment Ponds (Area F)

In fill areas west of the wastewater treatment ponds, barium, cadmium, lead, nickel, and arsenic were detected in the surficial soils in statistically significant concentrations above background. No metals in notable concentrations were detected in the subsurface soils samples. Barium and cadmium were detected in appreciable concentrations in the shallow groundwater in this area, probably the result of the groundwater mound in the area around the ponds. Cadmium was also detected in the french drain system in this area. It is likely that the french drain system has intercepted the groundwater containing cadmium in the vicinity of the wastewater treatment ponds.

#### 6.7.6 Fill Areas North of Wastewater Treatment Ponds (Area G)

In the fill areas north of the wastewater treatment ponds, barium, cadmium, and nickel were detected in both the surficial soil and subsurface soil samples. In addition, chromium, and arsenic were detected in statistically



significant concentrations in the surficial soils; zinc was detected in samples collected during installation of well 8S. Lead was detected in notable concentrations in the subsurface soils although not significant in the surficial soil samples. These data indicate that fill materials were placed at least at shallow depths in this fill area.

The shallow groundwater in this area contains appreciable concentrations of barium and cadmium, probably the result of leaching of materials contained in the fill area.



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